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New Early Eocene Species of *Arca* s.s. (Mollusca: Bivalvia) from Southern California

by

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Abstract. Two new species of the warm-water marine bivalve *Arca* s.s. are reported from the early Eocene of Ventura County, southern California. They represent the earliest species of *Arca* s.s. known from the Pacific coast of North America.

Arca (*Arca*) ***filewiczi*** sp. nov. is from the early early Eocene part of the "Meganos Stage" in the upper Santa Susana Formation, north side of Simi Valley, southern California.

Arca (*Arca*) ***givensi*** sp. nov., a previously unnamed species from the middle early Eocene "Capay Stage," part of the Juncal Formation, Pine Mountain area, southern California, is now named and described.

INTRODUCTION

The living arcid bivalve *Arca* s.s. has worldwide distribution in tropical and warm seas (REINHART, 1935). There is no agreement as to when *Arca* s.s. first appeared in the fossil record. It has been reported from strata of Early Cretaceous age in southern England (WOODS, 1899; REINHART, 1935; CASEY, 1961:605). NEWELL (1969), however, reported its geologic range to be Late Cretaceous to Recent.

Arca s.s. does not show up in the fossil record of the Pacific coast of North America until early Eocene time, based on my recent discovery of *A.* (*A.*) ***filewiczi*** sp. nov. in rocks of this age in southern California. Because this new species has no Cretaceous or Paleocene ancestral species of *Arca* s.s. in the Pacific coast region of North America (REINHART, 1943; MOORE, 1983), it must have immigrated into southern California. Like many other Old World mollusks that immigrated into southern California during the early Eocene, the route of migration was most likely by way of Central America (SQUIRES, 1987). The time of arrival of *Arca* s.s. into California coincided with a worldwide warming trend (HAQ, 1981).

Previously, the earliest record of *Arca* s.s. from the Pacific coast of North America was *A.* (*A.*) n. sp.? Givens, 1974, from strata of middle early Eocene age, southern California. This species is herein named and described as *A.* (*A.*) ***givensi*** sp. nov.

The terms "Meganos Stage" and "Capay Stage" used in this report refer to Pacific coast of North America provincial megainvertebrate stages as used by SAUL (1983) who regarded the "Meganos Stage" as late Paleocene to early early Eocene and the restricted "Capay Stage" of GIVENS (1974) as middle early Eocene.

Abbreviations used for catalog and/or locality numbers are: CSUN, California State University, Northridge; LACMIP, Natural History Museum of Los Angeles County, Invertebrate Paleontology Section; UCR, University of California, Riverside.

STRATIGRAPHIC OCCURRENCES AND GEOLOGIC AGES

Arca (*A.*) ***filewiczi*** was found in the upper part of the Santa Susana Formation at locality CSUN 965 (Figure 1) at 518 m (1700 ft) elevation, on the east side of an abandoned oil-well road long the west side of a ridge, 137 m (450 ft) south and 792 m (2600 ft) east of the northwest corner of section 32, T3N, R17W, Santa Susana quadrangle (7.5 minute), 1951, north side of Simi Valley, Ventura County, California. The locality is about 100 m stratigraphically below the basal conglomerate of the Llajas Formation, which disconformably overlies the Santa Susana Formation. No age-diagnostic microfossils have ever been found in this part of the Santa Susana Formation. Earliest Eocene calcareous nannofossils, however, have been found in the immediately underlying strata, and using this information FILEWICZ & HILL (1983:fig. 5) assigned an early Eocene age (CP9 Zone of OKADA & BUKRY, 1980) to the upper 100 m of the Santa Susana Formation on the north side of Simi Valley. This age is equivalent to the

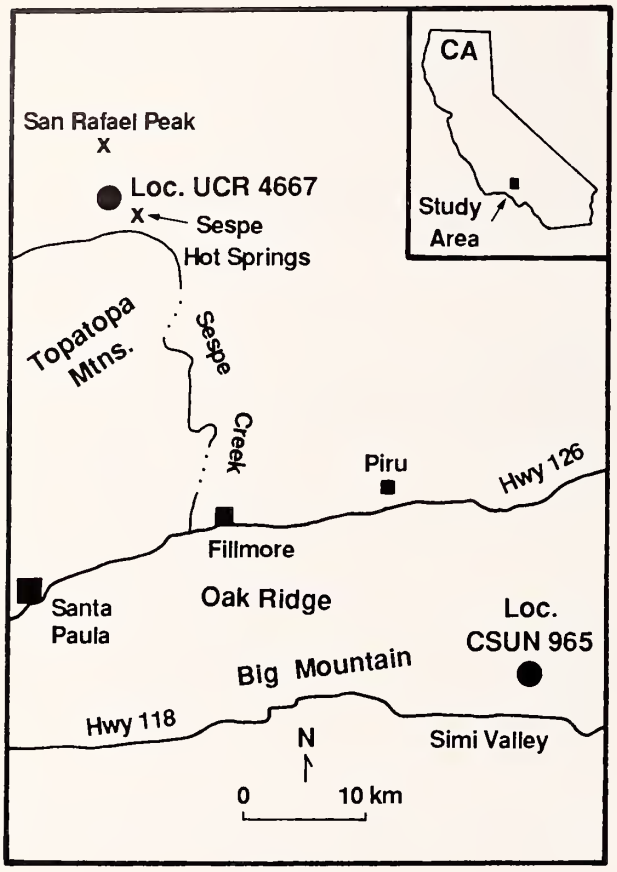


Figure 1

Geographic occurrences of two new species of early Eocene *Arca* s.s. in southern California.

early early Eocene part of the "Meganos Stage," and SAUL (1983) assigned the upper 100 m of the Santa Susana Formation on the north side of Simi Valley to this stage.

Two specimens of *Arca* (*A.*) ***filewiczi*** were found, and one is complete. They are from a lens of greenish gray, very fine sandstone surrounded by sandy siltstone. Associated macrofossils were abundant specimens of the gastropod *Turritella andersoni susanae* Merriam, 1941, and rare specimens of the brachyuran crabs *Cyclocoryestes aldersoni* Squires, 1980, and *Zanthopsis hendersonianus* Rathbun, 1926. The fossils in the lens are interpreted to be a very slightly transported assemblage in a relatively shallow offshore environment. This interpretation is in agreement with what HEITMAN (1983) found on the basis of his paleoecologic study of benthic foraminifers from this formation. He discovered that although paleobathymetry for the Santa Susana Formation on the north side of Simi Valley was mostly restricted to the bathyal realm, the upper part represents a shoaling event associated with basin filling that deposited silty sandstone just above the shelf-slope break.

Arca (*A.*) ***givensi*** was found in the lower part of the Juncal Formation at locality UCR 4667 (Figure 2) at 1097 m (3600 ft) elevation, on the east side of a south-draining tributary to Hot Springs Canyon, 518 m (1700 ft) south and 427 m (1400 ft) east of the northwest corner of section 21, T6N, R20 W, Topatopa Mountains quadrangle (7.5 minute), 1943, Ventura County, California (GIVENS, 1974). The locality is about 53 m stratigraphically above the base of the Juncal Formation, and GIVENS (1974) assigned this part of the Juncal Formation to the *Turritella uvasana infera* fauna of the middle early Eocene "Capay Stage."

Nineteen specimens of *Arca* (*A.*) ***givensi*** were found, and all are single valves. They are from a greenish gray sandstone bed within a predominantly mudstone facies. Associated macrofossils listed by GIVENS (1974:table 1) are other bivalves and some gastropods, including *Turritella andersoni* Dickerson, 1916. GIVENS (1974) interpreted that the rocks surrounding locality UCR 4667 were deposited in a nearshore, tropical or subtropical shallow-marine environment.

SYSTEMATIC PALEONTOLOGY

Family ARCIDAE Lamarck, 1809

Subfamily ARCINAE Lamarck, 1809

Genus *Arca* Linné, 1758

Type species: By subsequent designation (SCHMIDT, 1818), *Arca noae* Linné, 1758, ICZN Opinion 189, 5 October 1944.

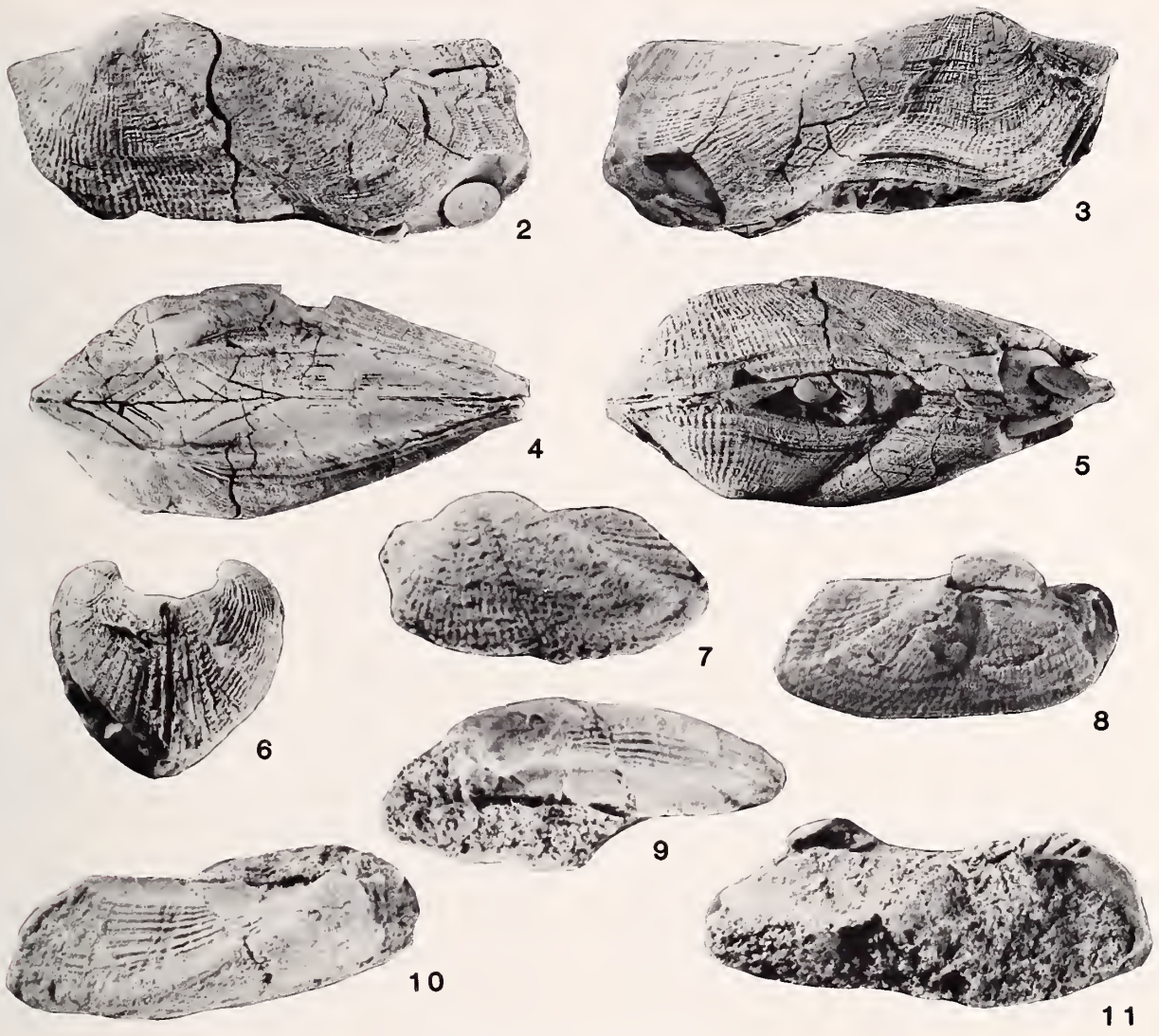
Subgenus *Arca* s.s.

Arca (*Arca*) ***filewiczi*** Squires, sp. nov.

(Figures 2–6)

Diagnosis: Medium size, with a weak posterior umbonal flexure, two to three radial bands on post-umbonal slope, and slightly concave ligamental area with four chevron-shaped grooves.

Description: Medium size, rhombic, very inequilateral, umbones prominent, beaks approximately one-fourth of length of shell from anterior end. Weak posterior umbonal flexure. Anterior margin parallel with posterior margin, both meeting straight hinge line at a nearly 90° angle. Ventral margin straight. Entire shell U-shaped in profile. Ligamental area extremely wide, slightly concave in umbonal area and slightly convex in posterior region of shell. Ligamental area with four chevron-shaped grooves in vicinity of beak, smooth posteriorly. Ligamental area on each valve subrectangular in shape, widest just posterior of beak. Medial sulcus from umbonal area to posterior end of byssal sinus on ventral surface of each valve; growth lines on right valve more deflected by the sinus than on left valve. Shell with fine cancellate sculpture; two to three fairly prominent radial bands on post-umbonal area. Radial ribs also di-



Explanation of Figures 2 to 11

Figures 2 to 6. *Arca* (*Arca*) ***filewiczi*** Squires, sp. nov., holotype, LACMIP 8365, locality CSUN 965, ×1.2. Figure 2: left valve. Figure 3: right valve. Figure 4: dorsal view. Figure 5: ventral view. Figure 6: anterior view.

Figures 7 to 11. *Arca* (*Arca*) ***givensi*** Squires, sp. nov., locality UCR 4667. Figure 7: paratype, UCR 4667/132, left valve, ×10. Figure 8: holotype, UCR 4667/131, right valve, ×6.9. Figures 9–11: paratype, UCR 4667/133. Figure 9: dorsal view, ×5.8. Figure 10: oblique dorsal view, ×5.8. Figure 11: interior, ×6.2.

rectly beneath beaks, extending a small distance onto ligamental area.

Holotype: LACMIP 8365.

Type locality: Locality CSUN 965, north side of Simi Valley, Ventura County, southern California.

Paratype: LACMIP 8366.

Dimensions: Of holotype, height 24 mm, length 59 mm, single-valve thickness 13 mm; of paratype, height 8 mm, length 11 mm (incomplete), single-valve thickness 3 mm.

Discussion: The morphologic characteristics of *Arca* s.s. have been described by REINHART (1935) and NODA (1966). Some of the most important of these are a wide ligamental area and an elongate posterior region with a depressed area between the hinge line and umbonal flexure. The new species has all of the requisite external characters. Unfortunately, no internal features could be observed without destroying the only two specimens of the new species. The match of external morphology, however, is sufficient to assign the new species to *Arca* s.s.

Arca (*A.*) ***filewiczi*** most resembles *A.* (*A.*) *biangula* LA-

MARCK (1805: 219; 1807: pl. 17, figs. 2a, b, expl. p. 238; PALMER, 1977: pl. 24, figs. 5a, b, c; COSSMANN & PISSARRO, 1904–1906: pl. 35, fig. 110-1; BRITISH MUSEUM (NATURAL HISTORY), 1975: pl. 6, fig. 10) from early Eocene (Cuisian Stage) through late Eocene (Bartonian Stage) strata in the Paris Basin, France, and Hampshire Basin, southern England. *Arca* (*A.*) ***filewiczi*** was compared to a specimen of *A.* (*A.*) *biangula* from the UCMP Cloez collection of Paris Basin Paleogene mollusks, as well as to published figures of *A.* (*A.*) *biangula*. These comparisons revealed that *A.* (*A.*) ***filewiczi*** differs from *A.* (*A.*) *biangula* in the following features: much weaker posterior umbonal flexure, beaks one-fourth rather than one-fourth to one-third of length of shell from anterior end, fewer and less prominent radial ribs on post-umbonal slope, four rather than six chevron-shaped grooves in ligamental area, chevron-shaped grooves confined to beneath umbonal area rather than throughout ligamental area, ligamental area on each valve more rectangular in shape rather than triangular, and a much smaller byssal gape.

Arca (*A.*) ***filewiczi*** differs from *A.* (*A.*) ***givensi*** in the following features: six times larger, much weaker posterior umbonal flexure, beaks one-fourth rather than one-third of length of shell from anterior end, anterior and posterior margins both meet hinge line at a nearly 90° angle rather than curve to meet the hinge line, fewer and less prominent radial ribs on post-umbonal slope, four rather than one chevron-shaped groove in ligamental area, and a much more prominent byssal sinus on each valve.

On the basis of recent work by MOORE (1983), the only other Eocene *Arca* s.s. known from the Pacific coast of North America is *A.* (*A.*) *hawleyi* REINHART (1943:21–22, pl. 2, figs. 19–22) from late Eocene "Tejon Stage" strata in southern California (REINHART, 1943; WEAVER & KLEINPELL, 1963). *Arca* (*A.*) ***filewiczi*** differs from *A.* (*A.*) *hawleyi* in the following features: shell does not narrow posteriorly, weaker commarginal ribs, and four rather than three chevron-shaped grooves in ligamental area.

Etymology: The species is named for M. V. Filewicz for his long-term cooperation in providing calcareous nannofossil age dates for many Paleogene formations on the Pacific coast of North America.

Occurrence: Early early Eocene part of the "Meganos Stage," upper Santa Susana Formation, north side of Simi Valley, Ventura County, southern California, locality CSUN 965.

Arca (*Arca*) ***givensi*** Squires, sp. nov.

(Figures 7–11)

Arca (*Arca*) n. sp.? GIVENS, 1974: 40, pl. 1, fig. 8.

Diagnosis: Small size, with a strong posterior umbonal flexure, six to eight primary ribs on post-umbonal slope, and a flattish ligamental area with one chevron-shaped groove.

Description: Small size, rhombic, very inequilateral, umbones prominent, beaks approximately one-third of length of shell from anterior end, beaks overhang ligamental area. Strong carina-like posterior umbonal flexure. Anterior margin parallel with posterior margin, both curving toward straight hinge line. Ventral margin fairly straight. Ligamental area flat throughout, with one chevron-shaped groove in vicinity of beak, smooth elsewhere. Ligamental area widest opposite beak. Slight medial sulcus from umbonal area to center of ventral margin of each valve where there appears to be a slight byssal sinus. Shell with fine to fairly strong cancellation ornamentation. Radial ribbing strongest on post-umbonal slope with six to eight fairly strong radial ribs, interspaces with no interribs or with one or more interribs, the number increasing ventrally. Only portions of dentition observed; small, numerous teeth below beak and at least four large elongate teeth on posterior end.

Holotype: UCR 4667/131 (formerly UCR hypotype 4667/131).

Type locality: Locality UCR 4667, Pine Mountain area, Ventura County, southern California.

Paratypes: UCR 4667/132 and 4667/133.

Dimensions: Of holotype, height 3 mm, length 7 mm, single-valve thickness 1.5 mm; of paratype, UCR 4667/132, height 2 mm, length 4.5 mm, single-valve thickness 1 mm; of paratype, UCR 4667/133, height 4.5 mm, length 10 mm, single-valve thickness 2 mm.

Discussion: Nineteen specimens of the new species were collected by GIVENS (1974). Eight are right valves, seven are left valves, and four are fragments. No complete specimens were found. All of the specimens are small, and they may represent juveniles.

The external morphologic features of this new species, as well as the very small part of the dentition area that could be observed, match those described by NODA (1966) for *Arca* s.s.

Arca (*A.*) ***givensi*** is most similar to *A.* (*A.*) *hatchetigbeensis* HARRIS (1897:47, pl. 7, figs. 10–10a; TOULMIN, 1977:183–184, pl. 11, figs. 9–10) from the early Eocene Hatchetigbee Formation in southwestern Alabama (TOULMIN, 1977). *Arca* (*A.*) ***givensi*** differs from *A.* (*A.*) *hatchetigbeensis* in the following features: half the size, six to eight rather than only two radial ribs on the post-umbonal slope, and one rather than two chevron-shaped grooves in the ligamental area.

Arca (*A.*) ***givensi*** is also similar to *A.* (*A.*) *merriami* (VAN WINKLE, 1918:pl. 81, pl. 6, fig. 1; CLARK, 1925:80, pl. 13, figs. 5–8; WEAVER, 1943:pl. 66–67, pl. 11, fig. 8, pl. 12, figs. 3, 6–9, 12, 15) from Oligocene strata in the Grays Harbor area of southwestern Washington. *Arca* (*A.*) ***givensi*** differs from *A.* (*A.*) *merriami* in the following features: half the size, beaks approximately one-third rather than one-fourth of length of shell from anterior end, more

prominent radial ribs on post-umbonal slope, and presence of cancellate sculpture. *Arca* (*A.*) *merriami* closely resembles *A.* (*A.*) *washingtoniana* Dickerson, 1917, from Oligocene strata in southwestern Washington, and Effinger (1938) considered them to be the same species.

Arca (*A.*) ***givensi*** differs from *A.* (*A.*) ***filewiczi*** in the following features: one-sixth the size, much stronger posterior umbonal flexure, beaks one-third rather than one-fourth of length of shell from anterior end, anterior and posterior margins both curve to meet hinge line rather than intersect it at a nearly 90° angle, twice as many and less prominent radial ribs on post-umbonal slope, one rather than four chevron-shaped grooves in the ligamental area, and a much less obvious byssal sinus on each valve.

Etymology: The new species is named for C. R. Givens for this valuable contributions on Paleogene marine mollusks of North America. He also found the specimens of the new species.

Occurence: Middle early Eocene "Capay Stage" *Turritella uvasana infera* fauna of the Juncal Formation, Pine Mountain area, Ventura County, southern California, locality UCR 4667.

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